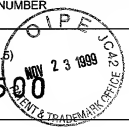


(1390 REV. 5-93) US DEPT. OF COMMERCE PATENT & TRADEMARK OFFICE		ATTORNEY'S DOCKET NUMBER 104788
<b>TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371</b>		U.S. APPLICATION NO. (if known, sec 37 C.F.R.1.5)  <b>09/424500</b>
		
INTERNATIONAL APPLICATION NO. PCT/JP99/01520	INTERNATIONAL FILING DATE March 25, 1999	PRIORITY DATE CLAIMED March 26, 1998
TITLE OF INVENTION METHOD OF MANUFACTURING SEMICONDUCTOR DEVICE, MOLDING DEVICE FOR SEMICONDUCTOR DEVICE, AND SEMICONDUCTOR DEVICE		
APPLICANT(S) FOR DO/EO/US Akira SATO (Suwa-shi, JAPAN)		
Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:		
1. <input checked="" type="checkbox"/> This is a <b>FIRST</b> submission of items concerning a filing under 35 U.S.C. 371.		
2. <input type="checkbox"/> This is a <b>SECOND</b> or <b>SUBSEQUENT</b> submission of items concerning a filing under 35 U.S.C. 371.		
3. <input checked="" type="checkbox"/> This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).		
4. <input type="checkbox"/> A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.		
5. <input checked="" type="checkbox"/> A copy of the International Application as filed (35 U.S.C. 371(c)(2)) <ul style="list-style-type: none"> <li>a. <input type="checkbox"/> is transmitted herewith (required only if not transmitted by the International Bureau).</li> <li>b. <input checked="" type="checkbox"/> has been transmitted by the International Bureau.</li> <li>c. <input type="checkbox"/> is not required, as the application was filed in the United States Receiving Office (RO/US)</li> </ul>		
6. <input checked="" type="checkbox"/> A translation of the International Application into English (35 U.S.C. 371(c)(2)).		
7. <input type="checkbox"/> Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)) <ul style="list-style-type: none"> <li>a. <input type="checkbox"/> are transmitted herewith (required only if not transmitted by the International Bureau).</li> <li>b. <input type="checkbox"/> have been transmitted by the International Bureau.</li> <li>c. <input type="checkbox"/> have not been made; however, the time limit for making such amendments has NOT expired.</li> <li>d. <input type="checkbox"/> have not been made and will not be made.</li> </ul>		
8. <input type="checkbox"/> A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).		
9. <input type="checkbox"/> An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).		
10. <input type="checkbox"/> A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).		
<b>Items 11. to 16. below concern other document(s) or information included:</b>		
11. <input checked="" type="checkbox"/> An Information Disclosure Statement under 37 CFR 1.97 and 1.98.		
12. <input type="checkbox"/> An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.		
13. <input checked="" type="checkbox"/> A FIRST preliminary amendment. <ul style="list-style-type: none"> <li><input type="checkbox"/> A SECOND or SUBSEQUENT preliminary amendment.</li> </ul>		
14. <input type="checkbox"/> A substitute specification.		
15. <input type="checkbox"/> A small entity statement.		
16. <input checked="" type="checkbox"/> Other items or information: Request for Approval of Drawing Corrections		


U.S. APPLICATION NO. <u>097424500</u> 37 C.F.R.	INTERNATIONAL APPLICATION NO. PCT/JP99/01520	ATTORNEY'S DOCKET NUMBER 104788
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17. <input checked="" type="checkbox"/> The following fees are submitted:  <b>Basic National fee (37 CFR 1.492(a)(1)-(5)):</b>  Search Report has been prepared by the EPO or JPO.....\$840.00  International preliminary examination fee paid to USPTO (37 CFR 1.482).....\$670.00  No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2)).....\$760.00  Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO.....\$970.00  International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4).....\$ 96.00  <b>ENTER APPROPRIATE BASIC FEE AMOUNT =</b>	<b>CALCULATIONS</b>	<b>PTO USE ONLY</b>																																																																		
Surcharge of \$130.00 for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	\$ 840.00																																																																			
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 20%;">Claims</th> <th style="width: 20%;">Number Filed</th> <th style="width: 10%;">Number Extra</th> <th style="width: 10%;">Rate</th> <th style="width: 10%;"></th> <th style="width: 10%;"></th> </tr> <tr> <td>Total Claims</td> <td>30- 20 =</td> <td>10</td> <td>X \$ 18.00</td> <td>\$ 180.00</td> <td></td> </tr> <tr> <td>Independent Claims</td> <td>3- 3 =</td> <td>0</td> <td>X \$ 78.00</td> <td>\$</td> <td></td> </tr> <tr> <td colspan="3">Multiple dependent claim(s) (if applicable)</td> <td>+ \$260.00</td> <td>\$</td> <td></td> </tr> <tr> <td colspan="4"><b>TOTAL OF ABOVE CALCULATIONS =</b></td> <td>\$1020.00</td> <td></td> </tr> <tr> <td colspan="4">Reduction by 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed. (Note 37 CFR 1.9, 1.27, 1.28).</td> <td>\$</td> <td></td> </tr> <tr> <td colspan="4"><b>SUBTOTAL =</b></td> <td>\$1020.00</td> <td></td> </tr> <tr> <td colspan="4">Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 month from the earliest claimed priority date (37 CFR 1.492(f)).</td> <td>\$</td> <td></td> </tr> <tr> <td colspan="4"><b>TOTAL NATIONAL FEE =</b></td> <td>\$1020.00</td> <td></td> </tr> <tr> <td colspan="4"></td> <td style="text-align: right;">Amount to be refunded</td> <td style="text-align: center;">\$</td> </tr> <tr> <td colspan="4"></td> <td style="text-align: right;">Charged</td> <td style="text-align: center;">\$</td> </tr> </table>	Claims	Number Filed	Number Extra	Rate			Total Claims	30- 20 =	10	X \$ 18.00	\$ 180.00		Independent Claims	3- 3 =	0	X \$ 78.00	\$		Multiple dependent claim(s) (if applicable)			+ \$260.00	\$		<b>TOTAL OF ABOVE CALCULATIONS =</b>				\$1020.00		Reduction by 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed. (Note 37 CFR 1.9, 1.27, 1.28).				\$		<b>SUBTOTAL =</b>				\$1020.00		Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 month from the earliest claimed priority date (37 CFR 1.492(f)).				\$		<b>TOTAL NATIONAL FEE =</b>				\$1020.00						Amount to be refunded	\$					Charged	\$		
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**NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.**

**SEND ALL CORRESPONDENCE TO:**  
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 P.O. Box 19928  
 Alexandria, Virginia 22320

  
 NAME: James A. Oliff  
 REGISTRATION NUMBER: 27,075  
  
 NAME: Thomas J. Pardini  
 REGISTRATION NUMBER: 30,411

PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of

Akira SATO

Application No.: U.S. National Stage of PCT/JP99/01520

Filed: November 23, 1999

Docket No.: 104788

For: METHOD OF MANUFACTURING SEMICONDUCTOR DEVICE, MOLDING  
DEVICE FOR SEMICONDUCTOR DEVICE, AND SEMICONDUCTOR DEVICE

PRELIMINARY AMENDMENT

Assistant Commissioner of Patents  
Washington, D. C. 20231

Sir:

Prior to initial examination, please amend the above-identified application as follows:

IN THE CLAIMS:

Please amend claims 5, 6, 8, 14, 17-20, 25, 29 and 30 as follows:

Claim 5, line 2, change "any one of claims 1 to 4" to --claim 1--.

Claim 6, line 2, change "any one of claims 2 to 4" to --claim 2--.

Claim 8, line 2, change "any one of claims 2 to 4" to --claim 2--.

Claim 14, line 2, delete "or 13".

Claim 17, line 2, delete "or 16".

Claim 18, line 2, delete "or 16".

Claim 19, line 2, delete "or 16".

Claim 20, line 2, delete "or 16".

Claim 25, line 2, delete "or 16".

Claim 29, line 2, change "any one of claims 1, 2, 3, 4, 10, and 11" to --claim 1--.

Claim 30, line 2, delete "or 13".

REMARKS

Claims 1-30 are pending. By this Preliminary Amendment claims 5, 6, 8, 14, 17-20, 25, 29 and 30 are amended to eliminate multiple dependencies. Prompt and favorable examination on the merits is respectfully solicited.

Respectfully submitted,



James A. Oliff  
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In re the Application of

Akira SATO

Application No.: U.S. National Stage of PCT/JP99/01520

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For: METHOD OF MANUFACTURING SEMICONDUCTOR DEVICE, MOLDING  
DEVICE FOR SEMICONDUCTOR DEVICE, AND SEMICONDUCTOR DEVICE

REQUEST FOR APPROVAL OF DRAWING CORRECTIONS

Assistant Commissioner for Patents  
Washington, D.C. 20231

Sir:

The Examiner is requested to review and approve the proposed corrections to Figures 9  
and 10, marked in red on the attached copy of such drawing figures.

Upon approval by the Examiner, and upon allowance of this application, the formal  
drawings will be corrected.

Respectfully submitted,



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Registration No. 27,075

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6/6

FIG. 9

PRIOR ART

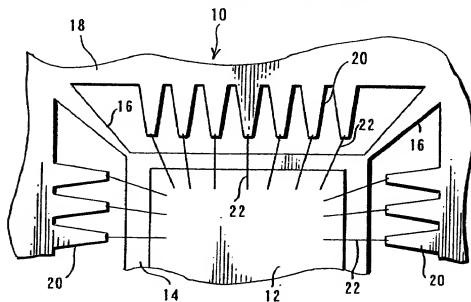
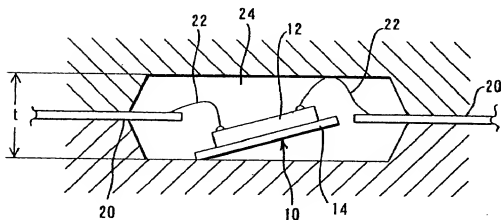


FIG. 10

PRIOR ART



METHOD OF MANUFACTURING SEMICONDUCTOR DEVICE, MOLDING  
DEVICE FOR SEMICONDUCTOR DEVICE, AND SEMICONDUCTOR DEVICE

TECHNICAL FIELD

5           The present invention relates to a method of  
manufacturing a semiconductor device, a molding device for  
a semiconductor device, and a semiconductor device.

BACKGROUND ART

10           A semiconductor device manufactured by securing a  
semiconductor chip to a die pad provided in a lead frame  
with an adhesive, connecting leads of the lead frame to  
electrodes of the semiconductor chip using gold wires to  
form a semiconductor assembly, placing the semiconductor  
15   assembly in a cavity, and curing a resin injected into the  
cavity so as to cover the semiconductor assembly has been  
known. Fig. 9 is a plan view showing part of such a  
semiconductor assembly.

          In a semiconductor assembly 10 shown in Fig. 9, a  
20   semiconductor chip 12 is secured to a die pad 14 which has  
a square or rectangular shape. Suspension leads 16 are  
provided to connect four corners of the die pad 14 to a  
lead frame 18 and support the die pad 14. The lead frame 18  
comprises a plurality of leads 20 between the suspension  
25   leads 16, and the leads 20 are connected to the terminals  
of the semiconductor chip 12 by wires (gold wires) 22.

          This semiconductor assembly 10 is placed in a cavity

with the leads 20 sandwiched between upper and lower molds and sealed with a resin injected into the cavity from a resin injection port of the mold which is provided at one corner of the die pad 14.

5           However, since the lead frame 18 supports the die pad 14 through the thin, narrow suspension leads 16, when the resin is injected into the cavity in which the semiconductor assembly 10 is placed, the semiconductor assembly 10 may tilt in a direction of the resin injection  
10 (in a direction along the axis of the resin injection port) or move up and down due to the flow of the injected resin in the cavity 24, as shown in Fig. 10. When manufacturing a semiconductor device having a total thickness "t" of 1 mm, 1.4 mm, or the like, the slight tilting or movement of the  
15 semiconductor assembly 10 may cause the die pad 14 or wires 22 to be in contact with the mold when the semiconductor assembly 10 is sealed, resulting in defective products in which the die pad 14 or wires 22 is exposed from the surface of the cured resin.

20           Therefore, conventional methods of eliminating such defects include a method of adjusting the height of the wires 22 in a wire bonding step in which the semiconductor chip 12 is connected to the leads 20 with the wires 22, or a method of changing molding conditions in the injection of  
25 the resin into the cavity 24. However, defective products with the die pad 14 or wires 22 exposed on the surface could not be eliminated due to fluctuation in processing or

the like. Because the molding conditions have been adjusted based on the results of previous molding, countermeasures to a change in materials tend to delay and the degree of adjustment of the molding conditions tends to be too small to adequately remove the above defect.

The present invention has been achieved to solve the above problems of the prior art and has an objective of eliminating the defects in the molding step of resin sealing.

#### DISCLOSURE OF THE INVENTION

In order to achieve the above-described objective, a method of manufacturing a semiconductor device according to the present invention comprises a step of placing a semiconductor assembly in which a semiconductor chip is secured to a die pad of a lead frame in a cavity of a mold and sealing the semiconductor assembly with a resin injected into the cavity, wherein at least one support pin positioned substantially on the axis of a resin injection port of the mold is caused to come in contact with the semiconductor assembly, and wherein the resin injected into the cavity from the resin injection port is cured after the support pin has been pulled into the mold.

According to the present invention, the semiconductor assembly does not tilt or move due to the flow of the resin because the resin is injected while the semiconductor assembly is supported by the support pin. Therefore, the

die pad or wires are not in contact with the mold, thereby eliminating defects such as exposure of the die pad or wires from the semiconductor assembly sealed with the resin. Moreover, since the support pins are pulled out of the mold cavity before the injected resin is cured, the semiconductor assembly is not exposed from holes which are formed in the points where the support pins have existed.

The semiconductor chip is not damaged if the support pin comes in contact with the die pad. The semiconductor assembly is supported more securely by arranging a plurality of support pins substantially on the axis of the resin injection port, thereby further reducing the tilting of the semiconductor assembly and the like. If pressure is applied to the semiconductor assembly by the support pins to move the assembly in a direction away from the previous position of the contact portion of the support pins, the support pins are pushed toward the mold by the semiconductor assembly due to the elasticity of the wires connecting the leads of the lead frame to the semiconductor chip and the suspension leads. Therefore, the semiconductor assembly is not lifted up by the resin even if the resin flows into the cavity under high pressure.

The semiconductor assembly may be placed in the cavity with the die pad either in the upper side or the lower side, depending on the client's request. If the semiconductor assembly is placed with the die pad in the lower side, the support pin is preferably provided on the

lower mold. If the semiconductor assembly is placed with the die pad in the upper side, the support pin is preferably provided on the upper mold. If the support pins are in contact with both the top and the bottom of the semiconductor assembly so as to sandwich the semiconductor assembly, the mispositioning of the semiconductor assembly can be more reliably prevented when injecting the resin. If a pair of support pins come in contact with the suspension leads which connect the die pad to the lead frame, the interval between the support pins becomes longer, whereby the semiconductor assembly can be securely supported.

In the method of manufacturing a semiconductor device according to the present invention, a heat radiator placed in a cavity of a mold is supported by at least one support pin provided substantially on the axis of a resin injection port; the mold is closed after a die pad of a lead frame to which a semiconductor chip is secured is placed on the heat radiator; and after the support pin is pulled into the mold, a resin injected into the cavity from the resin injection port is cured. According to the present invention, the heat radiator can be provided to the semiconductor assembly at the time of molding with the resin (sealing with the resin), thereby simplifying the manufacturing process.

If the heat radiator is supported by the support pin that is held by a recess formed on a lower surface of the heat radiator for preventing the heat radiator from moving,

displacement of the heat radiator at the time of placing the semiconductor assembly on the heat radiator can be prevented, whereby the position of the semiconductor assembly on the heat radiator can be precisely determined.

- 5 In this case, a plurality of support pins may be provided substantially on the axis of the resin injection port.

The molding device for carrying out the method of manufacturing the semiconductor device comprises: a mold which is capable of being opened or closed and is provided  
10 with a cavity for placing a semiconductor assembly which comprises a semiconductor chip secured to a die pad of a lead frame; a resin injection port provided to the mold for injecting a resin into the cavity; at least one support pin provided in the cavity substantially on the axis of the  
15 resin injection port such that the support pin is able to enter into or be pulled out of the cavity to come in contact with the semiconductor assembly in the cavity; and an actuator which moves the support pin in a direction of the axis of the support pin. Therefore, the semiconductor  
20 assembly does not tilt or move up and down, thereby eliminating defects such as exposure of the die pad or wires.

- The semiconductor assembly can be securely prevented from tilting by providing a plurality of support pins  
25 substantially on the axis of the resin injection port. The support pins may be provided in either the upper mold or the lower mold as required. The support pins may be

provided in both the upper and lower mold to sandwich the semiconductor assembly. Alternatively, the support pin may be provided at a position corresponding to the die pad so as to support the die pad. Instead, a pair of support pins

5 may be provided substantially on the axis of the resin injection port, and the support pins may be placed at positions corresponding to suspension leads which connect the die pad of the semiconductor assembly placed in the cavity to the lead frame to support the suspension leads.

10 If a servomotor is used as the actuator which moves the support pins in and out of the cavity, the vertical position of the support pin, the speed of pulling the support pin into the mold, operation mode, and the like can be optionally set. This ensures use of various types of

15 molds with ease and prevents the formation of bubbles and the like in the resin at the time of pulling the support pin. A semiconductor device according to the present invention can be manufactured by the method of any one of Claims 1 to 11. Therefore, defective products such as one

20 with an exposed die pad or wires can be eliminated.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 illustrates the molding device for a semiconductor device according to the first embodiment of

25 the present invention. Fig. 2 illustrates the position of the support pin according to the embodiment of the present invention. Fig. 3 illustrates the semiconductor assembly

supported by the support pin according to the embodiment of the present invention. Fig. 4 is a block diagram illustrating a method of manufacturing a semiconductor device according to the embodiment of the present invention.

5 Fig. 5 illustrates the molding device according to the second embodiment of the present invention. Fig. 6 illustrates the third embodiment of the present invention. Fig. 7 illustrates the fourth embodiment of the present invention. Fig. 8 illustrates the fifth embodiment of the present invention. Fig. 9 is a plan view showing part of a semiconductor assembly. Fig. 10 illustrates a conventional method of manufacturing a semiconductor device.

#### BEST MODE FOR CARRYING OUT THE INVENTION

15 A preferred embodiment of a method of manufacturing a semiconductor device, a molding device for a semiconductor device, and a semiconductor device according to the present invention will be described in more detail with reference to the drawings. Description of the parts described in the  
20 above prior art is omitted by using the same symbols.

Fig. 1 illustrates a molding device for a semiconductor device according to a first embodiment of the present invention. In Fig. 1, a molding device 30 comprises a mold 32. The mold 32 consists of an upper mold  
25 34 and a lower mold 36. The upper mold 34 and the lower mold 36 hold leads 20 of a semiconductor assembly 10 together and form a cavity 38 in which the semiconductor

assembly 10 is placed. A pair of through-holes 40 is formed in the lower mold 36, and support pins 42 which pass through the lower mold 36 using the through-holes 40 and are capable of moving in and out of the cavity 38 are provided.

The support pins 42 are provided at a position corresponding to a die pad 14 of the semiconductor assembly 10 placed in the cavity 38 to come in contact with the die pad 14. The lower ends of the support pins 42 are secured to a connecting member 44 to move up and down together with the connecting member 44. A rod 46 is connected to the bottom of the connecting member 44. The lower end of the rod 46 is engaged to a front cam 50 which is rotated by a servomotor 48 used as an actuator, to move up and down by the rotation of the front cam 50, as shown by an arrow 52. The support pins 42 are arranged on an axis 56 of a mold gate 54 formed in the lower mold 36 as a resin injection port as shown in Fig. 2. Specifically, the support pins 42 are arranged on the axis of the resin injection port in a plan view. The support pins 42 are provided so as to move in the direction intersecting the axis of the resin injection port.

In this embodiment, the die pad 14 is a square with a side length B of 9.5 mm, and an interval "p" between the support pins 42 is set at 6.5 mm. In the semiconductor assembly 10, a so-called depressing amount, specifically, an interval between the bottom of the lead 20 and the top

of the die pad 14 shown in Fig. 3 is set larger than usual. If the total thickness "t" of the semiconductor device sealed with the resin is 1 mm (see Fig. 1), an interval "a" between the bottom of the die pad 14 shown by a dot-dot-dash line in Fig. 3 and the surface of the cavity of the lower mold 36 when the semiconductor assembly 10 is placed in the lower mold 36 is set at 0.175 mm. The support pins 42 is in contact with the bottom of the die pad 14 to push up the die pad 14 as shown by the solid line in Fig. 3. In this embodiment, an interval "b" between the bottom of the die pad 14 pushed up by the support pins 42 and the surface of the cavity of the lower mold 36 is set at from 0.26 to 0.28 mm.

Fig. 4 is a block diagram illustrating a manufacturing process for a semiconductor device using the molding device shown in Fig. 1. The semiconductor assembly 10 in which terminals of the semiconductor chip 12 and the leads 20 of the lead frame are connected by wires 22 is preheated at about 165°C in order to improve affinity with the resin in step 60 in Fig. 4. The mold 32 is cleaned in step 61. After the mold 32 is cleaned, the preheated semiconductor assembly 10 is set in the lower mold 36 (step 62).

The support pins 42 are then raised by the rod 46 and the connecting material 44 by driving the servomotor 48 to rotate the front cam 50. The upper ends of the support pins 42 come in contact with the bottom of the die pad 14

of the semiconductor assembly 10 to support the semiconductor assembly 10 as shown in Fig. 1 (step 63). At this time, the vertical position of the support pins 42 is detected by a position sensor (not shown) to provide a

5 signal to a controller (not shown), and then the semiconductor assembly 10 is pushed slightly upward from the previous position shown by the dot-dot-dash line in Fig. 1 by the support pins 42 moved by the servomotor 48 controlled by the controller. If the thickness "t" of the

10 semiconductor device sealed with the resin is 1 mm, the semiconductor assembly 10 is moved 0.08 to 0.2 mm upward from the previous position of the contact portion of the support pins 42. Since the die pad 14 is pressed against the support pins 42 by the elasticity of the suspension

15 leads which connect the die pad 14 to the frame and the wires 22, the semiconductor assembly 10 is not pushed up by the flow of the resin even if the molding resin is injected from the mold gate 54 formed in the lower mold 36 under high pressure.

20 The upper mold 34 is then lowered to close the mold 32 (step 64). The mold may be closed before the support pins 42 come in contact with the semiconductor assembly 10. If the mold is closed before the support pins 42 come in contact with the semiconductor assembly 10, the

25 semiconductor assembly 10 does not tilt or become out of position when the support pins 42 come in contact with the semiconductor assembly 10.

After the mold is closed, the molding resin is injected into the cavity 38 through the mold gate 54 (step 65). In this embodiment, the molding resin is adjusted to be cured within about 180 seconds. After the resin is  
5 injected into the cavity 38, the servomotor 48 is reversed at an appropriate time to pull the support pin 42 into the lower mold 36 while applying pressure to the resin in the cavity 38 (step 66). In this embodiment, the support pins 42 are pulled into the mold after 12 seconds have elapsed  
10 from the completion of the resin injection. The pulling rate of the support pins 42 is controlled so as not to form bubbles in the resin. When the support pins 42 are pulled into the lower mold 36, the resin flows into the space which the support pins 42 have occupied, to fill the space.

15 Pressure is continuously applied to the resin in the cavity 38 until the resin is cured (step 67). After the resin is cured, the mold 32 is opened in a step 68 and the semiconductor assembly 10 is pushed up using an ejector pin provided in the lower mold 36 and removed from the mold 32  
20 (step 69). The semiconductor assembly 10 removed from the mold 32 is conveyed to the next step (step 70).

In this embodiment, since the resin is injected into the cavity 38 while supporting the semiconductor assembly 10 with the support pins 42 which are in contact with the  
25 bottom of the die pad 14, the semiconductor assembly 10 does not tilt or is not drawn down by the flow of the resin. Moreover, since the semiconductor assembly 10 is slightly

pressed upward from the previous position of the contact portion of the support pins 42, the pressure prevents the semiconductor assembly 10 from floating up by the flow of the resin. Therefore, defects such as exposure of the die pad 14 or wires 22 can be eliminated.

In this embodiment, since the support pins 42 are actuated by the servomotor 48, height of the projected support pins 42, operation rate, operation method, and the like can be optionally set, whereby conditions suitable for various packages can be set. Moreover, since the movement of the semiconductor assembly by the flow of the resin can be prevented in this embodiment, adjustment of the molding conditions is not needed, whereby processability of the molding step can be improved.

In this embodiment, although a pair of support pins 42 is provided, one or three support pins 42 may be used. If only one support pin 42 is used, it is preferable that the support pin 42 support the center of the die pad 14. In this case, the semiconductor assembly 10 can be supported more stably by providing a support pin having an elliptical top surface in which a diameter in a direction of the axis 56 of the mold gate 54 is longer. In this embodiment, although the servomotor 48 is used as an actuator, a cylinder or the like may be used instead.

Fig. 5 illustrates the second embodiment. A support pin 82 is provided on the upper mold 34 in a molding device 80. A support pin 82 is arranged so as to be able to enter

into or be pulled out of the upper mold 34 as shown by an arrow 84, and come in contact with an upper surface of the die pad 14 of the semiconductor assembly 10 that is placed in the cavity 38. The semiconductor chip 12 is provided on a lower surface of the die pad 14.

In the second embodiment constituted in this manner, the same effects as in the above embodiment can be obtained by injecting the molding resin into the cavity 38 while supporting the die pad 14 of the semiconductor assembly 10 with the semiconductor chip 12 on the lower surface by the support pin 82. In this embodiment, a plurality of support pins 82 may be used instead.

Fig. 6 illustrates a third embodiment of the present invention. In a molding device 86 according to this embodiment, the support pins 82 and 42 are provided on the upper mold 34 and the lower mold 36, respectively, to support the top and bottom of the semiconductor assembly 10 placed in the cavity 38. In this embodiment, since the support pins 82 and 42 support the top and bottom of the semiconductor assembly 10, movement of the semiconductor assembly 10 due to the flow of the injected resin can be completely eliminated.

Fig. 7 shows a fourth embodiment of the present invention. In the fourth embodiment, a pair of support pins 42 is provided so as to be able to enter into or be pulled out of the lower mold 36. These support pins 42 are provided at a position corresponding to the suspension

leads 16 which connect the die pad 14 to the lead frame.  
The support pins 42 come in contact with the lower surfaces  
of the suspension leads 16 to support the semiconductor  
assembly 10. The suspension leads 16 to be in contact with  
5 the support pins 42 are provided at a corner of the die pad  
14 corresponding to the mold gate and also at the opposite  
corner. In the fourth embodiment, since the suspension  
leads 16 to be supported are positioned at the facing  
corners of the die pad 14, the interval "p" between the  
10 support pins 42 can be made relatively large, whereby the  
semiconductor assembly 10 can be supported more stably.

Fig. 8 shows a fifth embodiment of the present  
invention. In this embodiment, a semiconductor device  
having a heat sink is manufactured. A heat radiator 70 is  
15 disposed in the cavity 38 of the lower mold 38 and  
supported by the support pin 42 as shown by the broken line  
in Fig. 8. A recess 72 is formed in the center of the  
bottom of the heat radiator 70 for preventing  
mispositioning. The upper end of the support pin 42 is  
20 secured in the recess 72 to support the heat radiator 70.  
The semiconductor assembly 10 is placed on the upper side  
of the heat radiator 70 supported by the support pin 42.  
After the semiconductor assembly 10 is disposed, the upper  
mold 34 is closed and the resin is injected into the cavity  
25 38. After the resin is injected, the support pin 42 is  
pulled into the lower mold 36 at an appropriate time as  
shown by the solid line in Fig. 8, and the resin is cured

as described.

In this embodiment, the heat radiator 70 can be provided to the semiconductor assembly 10 when sealing with the resin, thereby simplifying the manufacturing process.

- 5 Moreover, since the support pin 42 is secured in the recess 72, the heat radiator 70 is not out of position nor does it fall off the support pin 42 when the semiconductor assembly 10 is placed on the heat radiator 70. Therefore, the heat radiator 70 and the semiconductor assembly 10 can be
- 10 precisely positioned. In this embodiment, a plurality of support pins 42 may be provided.

## CLAIMS

1. A method of manufacturing a semiconductor device comprising a step of placing a semiconductor assembly in  
5 which a semiconductor chip is secured to a die pad of a lead frame in a cavity of a mold and sealing the semiconductor assembly with a resin injected into the cavity,

wherein at least one support pin positioned  
10 substantially on the axis of a resin injection port of the mold is caused to come in contact with the semiconductor assembly; and

wherein the resin injected into the cavity from the resin injection port is cured after the support pin has  
15 been pulled into the mold.

2. The method of manufacturing a semiconductor device as defined in claim 1, wherein the support pin is caused to come in contact with the die pad of the semiconductor  
20 assembly.

3. The method of manufacturing a semiconductor device as defined in claim 1, wherein a plurality of the support pins are arranged substantially on the axis of the resin  
25 injection port.

4. The method of manufacturing a semiconductor device

as defined in claim 2, wherein a plurality of the support pins are arranged substantially on the axis of the resin injection port.

5           5. The method of manufacturing a semiconductor device as defined in any one of claims 1 to 4,

          wherein the semiconductor assembly is pushed by the support pin in a direction away from the previous position of the contact portion of the support pin.

10           6. The method of manufacturing a semiconductor device as defined in any one of claims 2 to 4,

          wherein the semiconductor assembly is placed in the cavity with the die pad provided on the lower side.

15           7. The method of manufacturing a semiconductor device as defined in claim 5,

          wherein the semiconductor assembly is placed in the cavity with the die pad provided on the lower side.

20           8. The method of manufacturing a semiconductor device as defined in any one of claims 2 to 4,

          wherein the semiconductor assembly is placed in the cavity with the die pad provided on the upper side.

25           9. The method of manufacturing a semiconductor device as defined in claim 5,

wherein the semiconductor assembly is placed in the cavity with the die pad provided on the upper side.

10. The method of manufacturing a semiconductor device as defined in claim 1,

wherein the support pins are caused to come in contact with both the top and bottom of the semiconductor assembly.

11. The method of manufacturing a semiconductor device as defined in claim 1,

wherein a pair of support pins is caused to come in contact with the suspension leads that connect the die pad to the lead frame.

12. A method of manufacturing a semiconductor device comprising the steps of:

supporting a heat radiator placed in a cavity of a mold with at least one support pin provided substantially on the axis of a resin injection port;

placing a die pad of a lead frame to which a semiconductor chip is secured on the heat radiator and closing the mold; and

curing a resin injected into the cavity from the resin injection port after pulling the support pin into the mold.

13. The method of manufacturing a semiconductor device as defined in claim 12,

wherein a recess for preventing mispositioning is formed on a lower surface of the heat radiator and the heat radiator is supported by the support pin in the recess.

14. The method of manufacturing a semiconductor device as defined in claim 12 or 13, wherein a plurality of the support pins are arranged substantially on the axis of the resin injection port.

15. A molding device for a semiconductor device comprising:

a mold which is capable of being opened or closed and is provided with a cavity for placing a semiconductor assembly which comprises a semiconductor chip secured to a die pad of a lead frame;

a resin injection port provided to the mold for injecting a resin into the cavity;

at least one support pin provided in the cavity substantially on the axis of the resin injection port such that the support pin is able to enter into or be pulled out of the cavity to come in contact with the semiconductor assembly in the cavity; and

an actuator which moves the support pin in a direction of the axis of the support pin.

16. The molding device for a semiconductor device as defined in claim 15, wherein a plurality of the support pins are arranged substantially on the axis of the resin injection port.

5

17. The molding device for a semiconductor device as defined in claim 15 or 16,

wherein the mold consists of an upper mold and a lower mold which together form the cavity, and the support  
10 pin is provided in the lower mold.

18. The molding device for a semiconductor device as defined in claim 15 or 16,

wherein the mold consists of an upper mold and a  
15 lower mold which together form the cavity, and the support pin is provided in the upper mold.

19. The molding device for a semiconductor device as defined in claim 15 or 16,

20 wherein the mold consists of an upper mold and a lower mold which together form the cavity, and the support pin is provided in each of the upper and lower molds.

25 20. The molding device for a semiconductor device as defined in claim 15 or 16,

wherein the support pin is provided at a position corresponding to the die pad of the semiconductor assembly

placed in the cavity.

21. The molding device for a semiconductor device as defined in claim 17,

5        wherein the support pin is provided at a position corresponding to the die pad of the semiconductor assembly placed in the cavity.

10       22. The molding device for a semiconductor device as defined in claim 18,

         wherein the support pin is provided at a position corresponding to the die pad of the semiconductor assembly placed in the cavity.

15       23. The molding device for a semiconductor device as defined in claim 19,

         wherein the support pin is provided at a position corresponding to the die pad of the semiconductor assembly placed in the cavity.

20

24. The molding device for a semiconductor device as defined in claim 15,

         wherein a pair of support pins is provided substantially on the axis of the resin injection port; and

25

         wherein the support pins are placed at positions corresponding to suspension leads which connect the die pad of the semiconductor assembly to the lead frame.

25. The method of manufacturing a semiconductor device as defined in claim 15 or 16, wherein the actuator is a servomotor.

5

26. The method of manufacturing a semiconductor device as defined in claim 17, wherein the actuator is a servomotor.

10

27. The method of manufacturing a semiconductor device as defined in claim 18, wherein the actuator is a servomotor.

15

28. The method of manufacturing a semiconductor device as defined in claim 19, wherein the actuator is a servomotor.

20

29. A semiconductor device manufactured by the method as defined in any one of claims 1, 2, 3, 4, 10, and 11.

30. A semiconductor device manufactured by the method as defined in claim 12 or 13.

# ABSTRACT

A semiconductor assembly (10) in which a semiconductor chip (12) is secured to a die pad (14) is placed in a cavity (38). A support pin (42) which is able to enter into or be pulled out of the cavity (38) is provided in a lower mold (36). The support pin (42) is provided on the axis of a mold gate provided in the lower mold (36) and can be moved up and down by a servomotor (48).

10 The support pin (42) comes in contact with the bottom of the die pad (14) to support the semiconductor assembly (10), thereby preventing the semiconductor assembly (10) from tilting or moving up and down due to the flow of the resin injected into the cavity (38).

15

FIG. 1

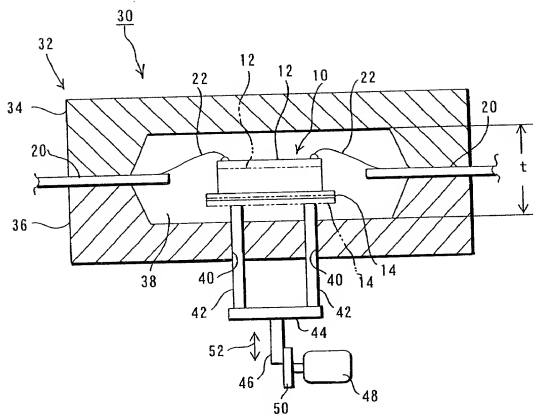


FIG. 2

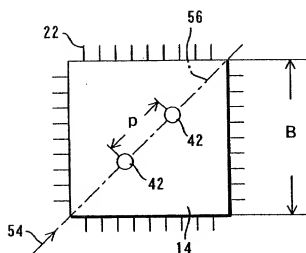
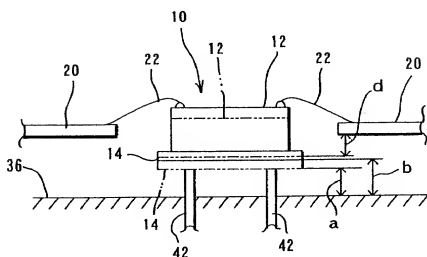


FIG. 3



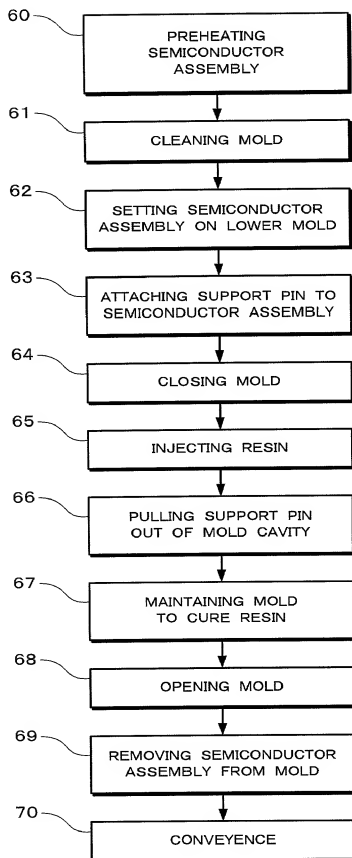
**FIG. 4**

FIG. 5

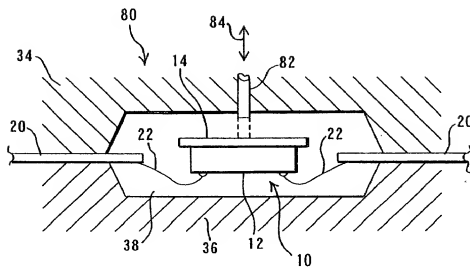


FIG. 6

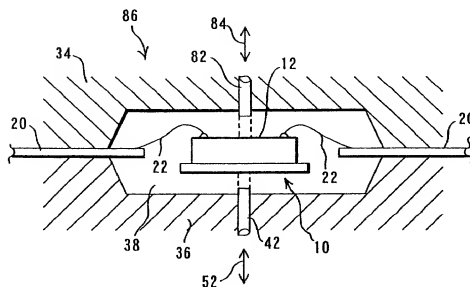


FIG. 7

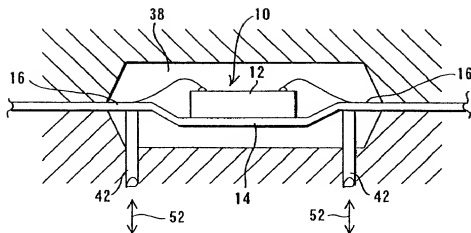


FIG. 8

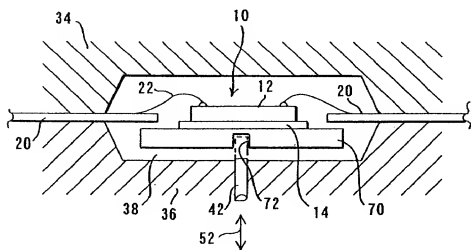


FIG. 9

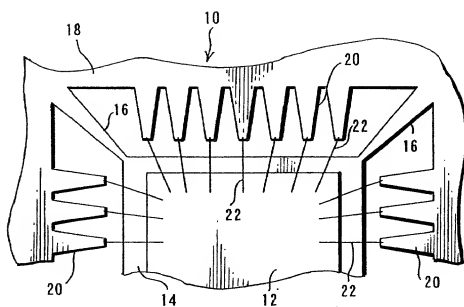
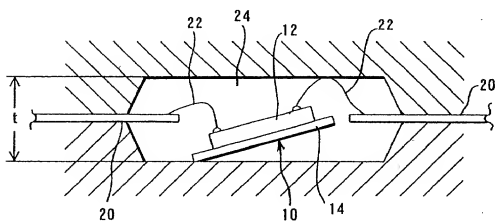


FIG. 10



Seiko Epson Ref. No.: F004440US00

Attorney's Ref. No.: 104788

## Declaration and Power of Attorney For Patent Application

特許出願宣言書及び委任状

## Japanese Language Declaration

## 日本語宣言書

下記の氏名の発明者として、私は以下の通り宣言します。

As a below named inventor, I hereby declare that:

私の住所、私書箱、国籍は、下記の私の氏名の後に記載された通りです。

My residence, post office address and citizenship are as stated next to my name.

下記の名称の発明に関して請求範囲に記載され、特許出願している発明内容について、私が最初かつ唯一の発明者（下記の氏名が一つの場合）もしくは最初かつ共同発明者であると（下記の名称が複数の場合）信じています。

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

半導体装置の製造方法、半導体装置のモールド装置及び半導体装置METHOD OF MANUFACTURING SEMICONDUCTOR DEVICE, MOLDING DEVICE FOR SEMICONDUCTOR DEVICE, AND SEMICONDUCTOR DEVICE

上記発明の明細書（下記の欄で×印がついていない場合は、本書に添付）は、

the specification of which is attached hereto unless the following box is checked:

- ☒ 1999年11月23日に提出され、米国出願番号または特許協定条約 国際出願番号を 09/424,500 とし、（該当する場合） \_\_\_\_\_ に訂正されました。

- ☒ was filed on November 23, 1999 as United States Application Number or PCT International Application Number 09/424,500 and was amended on \_\_\_\_\_ (if applicable).

私は、特許請求範囲を含む上記訂正後の明細書を検討し、内容を理解していることをここに表明します。

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

私は、連邦規則法典第37編第1条56項に定義されたとおり、特許資格の有無について重要な情報を開示する義務があることを認めます。

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

## Japanese Language Declaration

(日本語宣言書)

私は、米国法典第35編119条(a)-(d)項又は365条(b)項に基づき下記の、米国以外の国の少なくとも1ヶ国を指定している特許協力条約365条(a)項に基づく国際出願、又は外国での特許出願もしくは発明者証の出願についての外国優先権をここに主張するとともに、優先権を主張している、本出願の前に出願された特許または発明者証の外国出願を以下に、枠内をマークすることで、示しています。

I hereby claim foreign priority under Title 35, United States Code, Section 119 (a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed.

## Prior Foreign Application(s)

外国での先行出願

Priority Not Claimed

優先権主張なし

10-079874  
(Number)  
(番号)

Japan  
(Country)  
(国名)

March 26, 1998  
(Day/Month/Year Filed)  
(出願年月日)



(Number)  
(番号)

(Country)  
(国名)

(Day/Month/Year Filed)  
(出願年月日)



私は、第35編米国法典119条(e)項に基づいて下記の米国特許出願規定に記載された権利をここに主張いたします。

I hereby claim the benefit under Title 35, United States Code, Section 119 (e) of any United States provisional application(s) listed below.

(Application No.)  
(出願番号)

(Filing Date)  
(出願日)

(Application No.)  
(出願番号)

(Filing Date)  
(出願日)

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I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s), or 365 (c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code, Section 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of application:

PCT/JP99/01520  
(Application No.)  
(出願番号)

March 25, 1999  
(Filing Date)  
(出願日)

Pending  
(Status: Patented, Pending, Abandoned)  
(現況: 特許許可済、係属中、放棄済)

(Application No.)  
(出願番号)

(Filing Date)  
(出願日)

(Status: Patented, Pending, Abandoned)  
(現況: 特許許可済、係属中、放棄済)

私は、私自身の知識に基づいて本宣言書中で私が行なう表明が真実であり、かつ私が入手した情報と私の信じているところに基づく表明が全て真実であると信じていること、さらに故意になされた虚偽の表明及びそれと同等の行為は米国法典第18編第1001条に基づき、罰金または拘禁、もしくはその両方により処罰されると、そしてそのような故意による虚偽の声明を行えば、出願した、又は既に許可された特許の有効性が失われることを認識し、よってここに上記のごとく宣誓を致します。

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

## Japanese Language Declaration

(日本語宣言書)

委任状: 私は、下記の発明者として、本出願に関する一切の手続きを米特許商標局に対して遂行する弁理士または代理人として、下記の者を指名いたします。(弁理士、または代理人の氏名及び登録番号を明記のこと)

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Kirk M. Hudson, (Reg. 27,562)  
Thomas J. Pardini, (Reg. 30,411)  
Edward P. Walker, (Reg. 31,450)  
Robert A. Miller, (Reg. 32,771)  
Mario A. Costantino, (Reg. 33,565)

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (list name and registration number)

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Thomas J. Pardini, (Reg. 30,411)  
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日付

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2000年2月15日

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February 15, 2000

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日付

## Second inventor's signature

Date

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(Supply similar information and signature for third and subsequent joint inventors.)